Superior Juice Concentrate —Yet Only a Single Pass

Simultaneous flavor stripping and concentration nets product that reconstitutes with taste of starting juice

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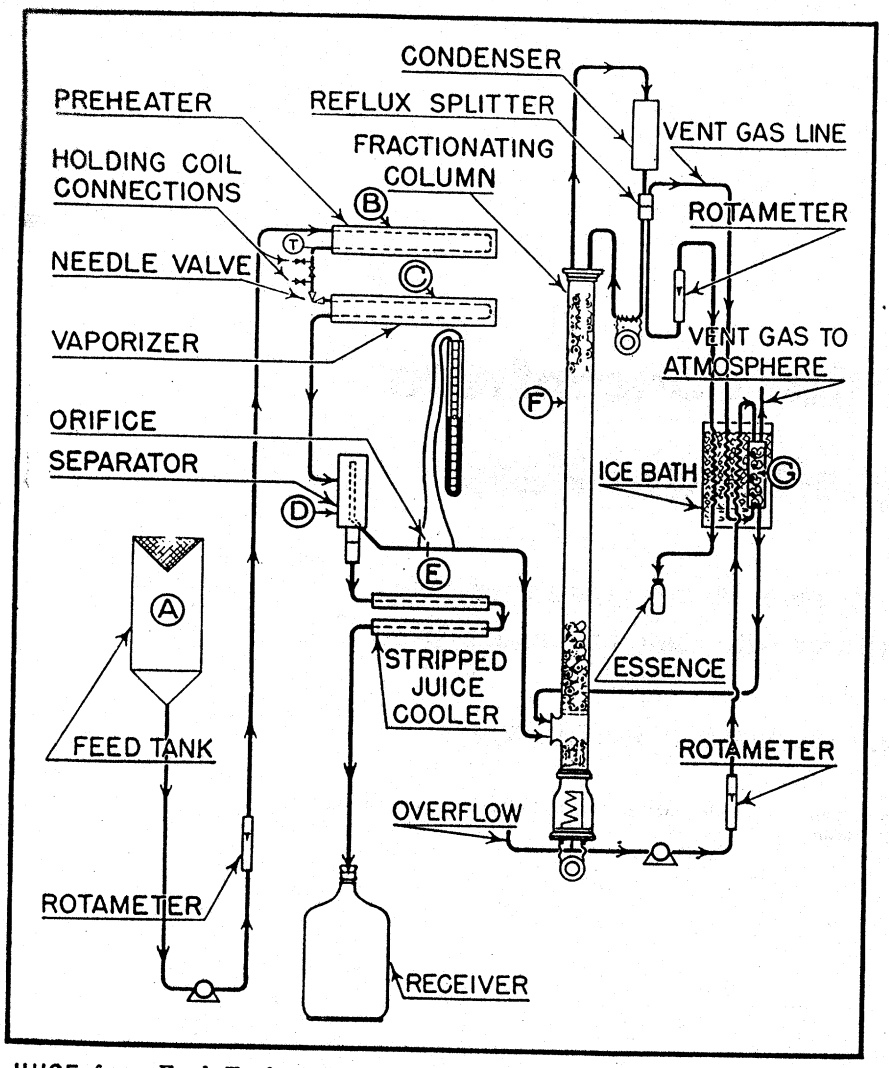
Process Traced From Feed Tank to Scrubber



JUICE from Feed Tank A is brought to 210 deg. F. in Preheater B, then flash-boiled in Vaporizer C. Vapor, separated at D, concentrated in Fractionating Column F and volatile aroma is liquefied in Ice Bath G.

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Just one pass—rather than two—will produce a full-flavored concentrated grape juice. This has now been demonstrated by a new process developed at Eastern Regional Research Laboratory.

■ **In this improved technic, essence is recovered and desired concentration attained simultaneously. And the reconstituted beverage is equivalent to the starting juice in both flavor and aroma.**

In an earlier process[1], full-flavored juice concentrates were made by stripping off only that portion of the juice necessary to release the volatile aroma. This stripped juice was further concentrated by vacuum evaporation. We found, however, that with improvements in evaporator design it is possible—at least with grape juice—to combine the steps of flavor stripping and concentration, conducting them simultaneously in the same equipment without damaging the juice by heat.

This is of interest, especially when a high degree of concentration of the stripped juice is not required. An example is frozen sweetened Concord grape juice concentrate of about 47 deg. Brix. Such a product is now made commercially. The juice is first concentrated to approximately 33½ deg. Brix, then sucrose is added (generally about 82 percent by weight of the natural grape sugar solids in the original juice). When diluted with three volumes of water to one of concentrate, the resulting beverage is a sweetened juice of about 14 deg. Brix.

Our work has resulted in a product similar to this but with a superior flavor. This is accomplished by restoring to the concentrate the aroma, which in conventional processes may be lost. In the finished product the essence-to-grape solids ratio is the same as that of the starting juice.

The starting material can be commercially pasteurized Concord grape juice of 15.5 deg. Brix that has (1) been stored under the customary conditions used to precipitate the argols and then (2) passed through a 30-mesh screen to remove the precipitate. To reach the required 33½ deg. Brix, it is necessary to vaporize 59.6 percent by volume of the juice. This can be done in a single pass without heat damage because as described below, the improved design of the preheater and vaporizer requires only a short retention time.

Operations Outlined

Referring to accompanying diagram in Preheater B the juice is brought to approximately 210 deg. F., at which temperature it passes directly into Vaporizer C. Steam pressure in the preheater jacket is approximately ⅓ psi., and in the jacket of the vaporizer 8 to 10 psi. The mixture of vapor and liquid discharging from the vaporizer passes to Separator D. Stripped and concentrated juice is rapidly cooled to room temperature in a water-jacketed cooling coil. The metered vapor, containing the aroma, is concentrated in the packed Fractionating Column F.

A portion of it is drawn off as essence, and the rest is returned to the column as reflux.

The essence is designated "100-fold by volume," since the rate of its draw-off is 1/100th of the feed rate of the juice. The latter rate is 1½ gal. per hr. Vent gases from the system are scrubbed in a chilled packed column countercurrently by column bottoms previously chilled to a temperature of 40 deg. F. Scrubbed vent gases and the column bottoms are substantially free of aroma. That part of the column bottoms not required for scrubbing the vent gas is discarded.

Accumulation of essence is started after the column has been operated for 2 hr. on total reflux (the time previously determined by hold-up measurements as that required to produce 100-fold essence at the top of the column when the juice feed rate is 1½ gal. per hr.) The essence is then put into the concentrated stripped juice. To this is added sucrose, equivalent to 82 percent of the grape solids in the concentrate. Thus, 45 percent of the total solids in the mixture is sucrose. For example, to 0.96 gal. of 35.5 deg. Brix concentrate is added 0.023 gal. of 100-fold essence and 2.52 lb. of sucrose.

After thorough mixing to dissolve the sugar, the product is transferred to 6-oz. cans, quickly frozen in brine at —20 deg. F., and stored at 0 deg. F.

When reconstituted with three volumes of water, this product was found equivalent in taste and aroma to the starting juice. Addition of sugar to the extent of 82 percent of the grape solids had sweetened the starting juice, which was then diluted with water to 14 deg. Brix. This and all other organoleptic evaluations were made by a taste panel skilled in the detection of slight differences in taste and aroma.

Unsweetened Concentrate

Using the same apparatus, it is possible to prepare (by a greater degree of vaporization during stripping) an unsweetened concentrate without damage to the flavor.

Pasteurized Concord grape juice such as was used in the above process is fed to the evaporator at the rate of 1.23 gal. per hr. Sufficient steam is used in the jacket of Preheater B to bring the juice to 210 deg. F. Approximately 73 percent by volume of the juice is then vaporized in Vaporizer C, the steam pressure in the jacket being adjusted and controlled to achieve this vaporization. Stripped juice, concentrated to approximately 48 deg. Brix, flows from Separator D at the rate of 0.33 gal. per hr. and is quickly cooled to about 80 deg. F.

From Separator D, the vapor and its associated aroma pass to Fractionating Column F. After the column has been operated for 2½ hr. on total reflux, essence is withdrawn from the reflux splitter at the rate of .0123 gal. per hr. Column bottoms are thus produced at 0.888 gal. per hr.

In operating Vent Gas Scrubber G, column bottoms are recirculated to the scrubber at the rate of 0.8 gal. per hr. Both the vent gases and discarded column bottoms will be substantially free of aroma.

To 0.62 gal. of the cooled juice concentrate there is added 0.023 gal. of essence. This is the quantity derived from the juice going into the concentrate. Thus 0.64 gal. of full-flavor unsweetened grape juice concentrate is obtained. After thorough mixing, the product is transferred to 6-oz. cans and then quickly frozen in brine at -20 and stored at 0 deg. F.

On reconstitution with three parts of water to one of concentrate, which gives a juice of 14 deg. Brix, the product was, for all practical purposes, indistinguishable in taste and aroma from the starting juice diluted with water to 14 deg. Brix. A further comparison was made with juice of the same Brix, reconstituted from a frozen concentrate of 47 deg. Brix made by a modification of the "double essence" process[2]. The modification consisted only in concentrating the stripped juice under vacuum to 48 instead of to 68 deg. Brix. Juices from the two types of frozen concentrate were indistinguishable.

Pending data on keeping quality, we can conclude that frozen sweetened or unsweetened concentrated Concord grape juice of good initial quality can be made by either of the following processes:

A. Vaporize in the essence unit sufficient juice to obtain, in one pass, the desired Brix (about 60 percent vaporization for sweetened juice and 72 percent for unsweetened juice), add the essence to the cooled juice concentrate (in making sweetened juice add sugar to the extent of 82 percent of the grape solids), package, and freeze.

B. Vaporize 25 percent of the juice in the essence unit and recover a first essence, complete the evaporation of the stripped juice to about 47 deg. Brix (or 33½ deg. Brix for sweetened concentrate) at a vacuum of at least 27½ in., recover a second essence by stripping 25 percent from the condensate obtained during the vacuum evaporation, incorporate both essences in the juice concentrate (adding sugar if desired), package, and freeze.

Equipment for Commercial Operation

In preparing both sweetened and unsweetened concentrates by this process, entailing simultaneous essence stripping and concentration, it was necessary to greatly reduce the rate of juice flow through the preheater and vaporizer. For the fractionating column was originally designed to accommodate only the vapor necessary for release of aroma and not the additional vapor incident to juice concentration. Thus, a unit designed to achieve the two operations simultaneously should have a column much larger with respect to the evaporator than ours had.

It is at once apparent, however, that there is no reason why vapor evolved in concentration of the juice, beyond the point where the aromas are substantially all released, need be sent to the column. A unit expressly designed for this process would, therefore, have two vaporizers. The first would merely strip out the volatile flavors, which would then pass to the fractionating column. The stripped juice would then pass to the second vaporizer, also operated at atmospheric pressure, and the vapors evolved there could be discarded to the atmosphere without condensation. Such a unit could also be used for making apple juice concentrates.

The second vaporizer, consisting merely of a system of tubes of small diameter and a pump for forcing the liquid through them at extremely high velocity, would probably cost much less than the conventional vacuum pan with its condenser and vacuum pump. It should also be less expensive to operate, since steam consumption would be slightly less than that of a vacuum pan, and no cooling water would be required. By using a portion of this vapor to preheat the juice, a further saving in operating cost could be obtained.

The question logically arises as to whether the juice could be subjected to two atmospheric evaporations without heat-damage. Further research is planned to establish this point. It seems probable, however, that this two-stage evaporation would not damage Concord grape juice, since the total effect of heat in a properly designed unit need be no greater than the heat effect resulting from operation of the single-stage evaporator far below its rated capacity, as was done in these experiments.

Storage tests are being carried out at 0 deg. F. on both the sweetened and unsweetened concentrate. The stored samples will be evaluated organoleptically in comparison with the same products stored at the temperature of solid carbon dioxide.

Concerning the manufacture and use of these volatile fruit flavor concentrates (essences), it should be noted that such operations are subject to

regulations of the Bureau of Internal Revenue, (*Federal Register*, 5869-79, Sept. 27, 1949).

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